SECRET

Progress Report

Period of March 15, 1962 to April 15, 1962

Contract No. AF33(600)40280

SECRET

Flight Test

Summary

A. General

During this reporting period, two system flights were made, S6 and S7, on 10 April.

Film data obtained during these flights is presently being evaluated. A preliminary quick-look indicated that target recording was better than the previous flights but still poor.

On flight S7, sizeable video signals (up to 8V peak to peak) were observed during aircraft maneuvers made before the data run was initiated. During the data run, random video signals up to 4V were observed.

The system sensitivity is 8 to 10 db below the design values which accounts for a major loss of target return, however, if targets have a dynamic range in the order of 20 to 30 db then more targets should possibly have been seen. Frequency control is a possible cause of target loss since in one area on flight S6, target density appeared good on the primary film.

An analysis of the primary film disclosed that the doppler patterns were going thru zero doppler. This was unexpected as the same effect was noted on the previous flight and the offset frequency was increased by an addition of 150 cps in order that no doppler below approximately 50 cps would occur. The fact that zero doppler is still present indicates that additional frequency shifts have occurred that have cancelled the 150 cps increase in the offset frequency, or,

possibly there is modulation occurring on the offset frequency. This will be further investigated in the next reporting period.

The low radiated power and poor modulator reliability are the items that have limited the quantity and quality of the inflight data as of this date. Steps are being taken to correct these discrepancies. In order to advance the system program, data will be gathered at a lower altitude (20,000 feet), which will give a higher target density. This change will allow analysis of system status in general, and the data processor and frequency control in particular.

B. System

During this reporting period, various modifications and tests were made in an effort to improve system performance.

1. Attempts to increase output power and improve modulator reliability were made throughout the month. The following "fixes" were tried:

a. New pulse forming network (0.4 usec instead of 0.6 usec).

b. Addition of inverse diode.

c. Increased 115V input to 118V. (The modulator reliability was low during this period.)

2. Tuning the duplexer did not substantially increase the average transmitted pulse power. The highest output power obtained during the month was approximately 100 Kw peak.

3. The buffer gate was made variable so that the wide pulse leak thru of the transmitted pulse could be reduced. This has substituted for the "tailbite" switch.

4. Holes were drilled in the switches to produce air flow to more quickly extinguish the arc.

5. A crossguide coupler was installed so that the buffer output power could be more readily measured.

6. The antenna servo was switched to the +150 (B) supply so that only the video amp would be on the +150 (A) supply thus provide greater disturbance isolation.

C. Instrumentation

No changes were made to the instrumentation configuration during this month. Oscillograph recordings were obtained during the two system flights. A summary of the data obtained is included in the data analysis section of this report.

D. Data Analysis

Two flights (S6 and S7) were flown during the reporting period, flights were made at altitudes of 40,000 feet and speeds of approximately 1.5M.

Flight S6 (4-10-62, Course #3 Mountains)

The oscillograph recording indicated an average drift angle of 1.25 degrees left. The frequency correction command varied from 4220 to 3620 cps. If ground speed is 830 knots and antenna acceleration along the beam is 0, the left drift angle and the frequency correction command generally agree. Pitch and roll perturbations have seldom exceeded 1 degree. Except for course corrections where roll was excessive, information from the oscillograph recording indicated no system failures.

Flight S7 (4-10-62, Course #4, Coastal)

During this flight a 4 to 6 degree left drift was experienced because of a crosswind. The frequency correction signal varied between 2610 and 3000 cps. If a 5 degree drift, 830 knots ground speed, and 0 antenna beam velocity are assumed, the doppler shift (f_d) should be 2030 cps.

The frequency correction command should read the offset frequency (4567 cps) minus f_d (2030), or 2537 cps. This is below the 2610 cps minimum frequency recorded during the flight. A drift angle of greater than 5 degrees exceeds the limits of the drift pot in the nav-tie unit. This is what occurred during S7, hence some of the data is not properly compensated. Power supply voltages and temperatures were found normal during the flight.

A more complete analysis of both flights is being conducted. An area of special interest is the change in frequency correction command when the ground speed, drift angle, or antenna beam velocity are varied.

Items investigated during current reporting period:

1. Modification to Recorder to Allow Low Altitude Flights. Recorder blanking switched with unblanking allows this operation. Keeping the ratio of slant range to ground velocity squared a constant will allow processing the data without altering film speed.

2. KPA Pulse Timing. The RF buffer pulse to the KPA was made as narrow as the ring charge would allow and was initiated coincident with the KPA high voltage pulse in order that the wide pulse leak thru (so called "front porch" and "back porch") was drastically reduced in the radiated signal. Since the wide pulse is 40 to 60 times the width in time of the desired pulse, it must be 20 to 30 db less than the desired pulse in peak amplitude in order for the wide pulse target return not to mask the desired pulse return.

3. Data Flash. Pick up of the data flash trigger pulse by the CRT causes striations on the film, therefore, the pick up is being eliminated by moving all data flash circuitry to one location.

4. Built in Test. Possible bit functions are being considered. No definite conclusions have been drawn as of this date.

5. Doppler Tracker. It is expected that the DT will be tied into system #2 during the next reporting period. Upon completion of the lab checkout it will be installed in the aircraft.

6. System Accelerometer. Sensitivity to slight changes in aircraft roll altitude probably makes it unuseable as presently mechanized. Data will be gathered in flight to determine if this is correct. Present instrumentation is marginal in sensitivity for this task.

7. Automatic Gain Control Circuit Modifications. Greater video output is required to drive the recorder cathode ray tube than the original system plans had indicated. The AGC amplifier, which samples the video output voltage, saturates under the increased video drive. Changes to this amplifier have eliminated the saturation for the present video drive levels. Other modifications to the AGC detector and filter have greatly increased the frequency response of the loop and will provide a stable control characteristic with a response of 100 Kc or more.

8. Receiver Characteristics. Measurement of receiver characteristics to determine dynamic range and limiting or saturation characteristics are in progress. Results indicate that the synchronous signal detector cannot provide a sharp limiting characteristic. The signal input must change by as much as 15 db to fully saturate the detector in relation to the linear operating region. This result indicated that further study must be made of the control of large isolated signals. Linear output is obtained over at least a 20 db dynamic range. Further tests of the receiver are planned in regard to film writing characteristics.

Antenna Fabrication

Antenna #1

Antenna No. 1 is complete in the flight test configuration with 6 modules. The parts for the additional 2 modules required for the final configuration are in work. The additional power divider parts required have been delivered to technicraft for assembly and test.

Antenna #2

Assembly is complete except for the input waveguide section which does not hold up electrical testing of the antenna. Satisfactory test patterns have been made in elevation. Azimuth patterns and gain measurements indicate that readjustment of the power divider phase shifters is necessary. Initial testing is to be completed the week of 16 April.

Antenna #3

Two modules had excessive air leakage during tests and are being reworked. The remaining six modules are in process of final assembly. All power divider parts have been delivered to Technicraft for assembly and test. Final assembly of the antenna will be started as soon as all modules are complete.

Switch Tubes

Emphasis this month was again placed on optimizing the isolation and breakdown time of WX-4641 and in reducing the random firing that occurs at high duty rates. Initially, a tube was fabricated and tested without a sweeping electrode. This tube was pressurized in order to permit operation at 60 Kw peak power at a 3600 cps rep. rate.

It worked very well but it was noted that even with a pressurized system, there occurred a random firing for a very small percentage of the total number of pulses. Insertion of a sweeping electrode led to trouble when the sweeping electrode insulator failed. This failure appeared to be due to a coupling out of rf power by the electrode wire. This condition is presently being corrected for further evaluation.

An objective for the coming period is to record some data of random breakdown vs. repetition rate to determine the highest rep. rate that might be used without need for a sweeping electrode.

Some time was spent this month in shielding of all high power components in order to reduce noise on the sampling scope. This effort has resulted in a considerable reduction in bothersome noise appearing on the pulse and measurements can more accurately be made.

Modulator

Continued trouble has been encountered in obtaining reliable components for the modulator. A modulator has been set up at the component manufacturer's facility to obtain the greatest development effort obtainable in a short time. Redesign of the pulse forming network and pulse transformer is underway. An auxiliary effort to determine modulator circuit component characteristics by means of an analog computer study is being planned.

Synchronizer

Frequency Generator

Parts for the 13 mc test output have been scheduled for shipment on 19 April.

Change orders have been issued to modify the buffer gating circuit to permit adjustment of the waveform shape and incorporate changes to improve the buffer on-off ratio.

Oscillator-Discriminator

It was noted during tests that oscillator and discriminator tracking was not within specifications. Efforts by the supplier are being directed toward correction of this condition.

Recorder

General

Testing on Recorder #3 is continuing. Assembly of Recorder #4 has started. A proposal for a study of fiber optics, CRT and film parameters has been received for approval. A G.E. micro-spot CRT has been received for evaluation.

Recorder #3

As a result of investigating the parameters affecting resolution, it was determined that problem areas were due to:

a. The 4400 volt focusing voltage required by the WX-4431 as compared to the high voltage power supply operating range of 3800-4100 volts.

b. 400 cycle magnetic fields from unshielded cables and filament transformers.

c. Corrective changes are being incorporated including additional magnetic shielding of the tube and this work is progressing satisfactorily.

At the present time the possibility appears remote for obtaining high resolution fiber optics with acceptable geometry of the reproduced trace. Experiments are now being conducted with rectangular fiber bundles assembled into a non-fused bundle in order to avoid one of the operations causing the breakage.

Recorder #4

During March, the structure and cover drawings were released for fabrication. This completes the release for recorder #4.

Assembly status is as follows:

1. Data Projector - 90% complete, lens being checked.
2. Prism Assembly - Complete.
3. M_1 & M_2 Assembly - Complete.
4. Lens & M3 Assembly - Complete except for lenses.
5. Structure - Received and assembly started.
6. CRT Assembly - Complete except for tube.

G. E. Micro-Spot CRT

Work has been progressing on the test set for evaluation of the G.E. Micro-Spot CRT. A support for the tube and associated deflection and focus coils has been constructed. Four regular potentiometers and two special tandem pots were received and have been installed and wired. Deflection coils are driven at a 4 Kc rate to display a line scan on the tube face. Work is now being done on a slow sweep orthogonal to the 4 Kc line scan. Preliminary observation shows a qualitatively promising high resolution trace, although quantitative measurements have not been made.

Frame

Truss

Detail drawings are 75% complete. The mock-up has been started and is now nearing completion. Stress analysis is 75% complete.

Spares

70% of the spares have been packaged and are ready for shipping.

Test Equipment

A. Composite Test Equipment

The composite test equipment was set up with the system.

B. Design Evaluation

All units with the exception of the film evaluator have been mounted in the rack and will be delivered within the next week.

All units have been tested individually and have been tested as a complete test set. The checks that have been made indicate that the test equipment is operating properly.

The design goals, as originally specified, have been met. The final test of course, will be operation with the system.

1. Transponder - The transponder is operating properly with the complete test set. No problems exist.

2. Clutter Generator - The clutter generator is operating properly with the complete test set. No problems exist.

3. Range Resolution Test Pattern Generator - The range resolution test pattern generator is operating properly with the complete test equipment. No problems exist.

4. Azimuth Resolution Test Pattern Generator - This unit is operating properly with the rest of the test equipment. However, the absolute frequency of the 30 mcps oscillator which is fed to the test equipment will fall outside the passband of the single sideband filters. This occurred because at the time these filters were purchased the absolute frequency of this oscillator was not known. It was pointed out that the broad tolerance allowed could cause this incompatibility to exist.

It was assumed at that time that the frequency of the oscillator would be variable and could be tuned to conform with the test equipment filters when the tests were being run.

New crystals have been ordered for these filters. The modified filters will be available for installation in the test equipment by May 1. Installation and adjustment of the test equipment to conform to this new frequency will take approximately one week.

5. Azimuth Resolution Optics Assembly - Some difficulty has been experienced in obtaining sufficient light intensity to observe the focus of the fresnal zone sections similar to pattern which will be on the film. The focal point falls very close to the light source. The stray light from the light source makes it rather difficult to observe the desired focal point.

Double images at the focal point have also caused some difficulty. It is felt that these occur due to the fact that the light passes thru the fresnal zone in order to illuminate the mirror and is then reflected thru the zone a second time to obtain a focus of the zone.

A breadboard set up of lens system which will replace the present mirror system is being constructed. This system will illuminate the fresnal zone from the rear and it is anticipated that a much greater light intensity will be observed at the focal point. The focal point will also be well removed from the light source therefore stray light from the source will not interfere with observation of the focal point.

The difficulty due to the double image should also be eliminated as the light will pass thru the zone only once.

6. Range Resolution and Dynamic Range Optics Assembly - No film has been available as yet that can be viewed on this evaluator. We have been able to obtain photographic gratings with line densities as high as seven hundred and fifty lines per inch. No problems were encountered in reading these gratings and it appears that the unit is capable of evaluating much higher line densities.

We feel some of the evaluator optics can be simplified. Experimental checks will be performed to determine to what extent if any such simplification will degrade the capabilities of the unit.

The evaluator is ready to be delivered but the bench which will hold the evaluators and the evaluator electronics has not been received from the supplier as yet.

7. Film Evaluator Electronic Circuitry - The electronic circuitry has been tested with the film evaluator and performs satisfactorily. No problems exist.

8. Mechanical Design and Packaging - All of the chassis have been mounted in the racks. The interconnecting cable has been installed. The cooling is functioning properly. The overall unit is functioning within the design goals originally specified.

Design Evaluation

Listed below are tests that have been conducted on System #3 in the design evaluation test program.

1. Receiver Pulse Response - A pulse signal was fed into the duplexer and observed at the video output. The equivalent resolution of this response is approximately 7.5 feet. Increase of the rise time was due to the IF and video amplifiers.

2. Receiver Dynamic Range (Without Recorder) - The range is greater than 30 db.

3. RF Stability Test of Stalo - A new modified LFE stability tester and panoramic tester are now available for system tests. The modified equipment has a frequency range of 5 cps to 5 kc. Tests indicate the maximum stalo frequency deviation is 40 cps. This deviation will result in target sidelobes of -24 db at a range of 40 miles. No significant disturbances were noted over the previously unexplored region which is between 5 and 20 cps.

4. Offset Frequency Stability - Slow drift of the offset control voltage produces a frequency drift that exceeds allowable tolerances. Changing the tube type in the summing amplifier resulted in a considerable reduction in the slow drift, however, the results are still marginal. The offset frequency drift of the frequency generator is approximately 200 cps over a period of one hour. This offset frequency is defined as the difference between the output frequency of the fixed frequency generator and the variable frequency generator.

Doppler Frequency Tracker

The status of the four basic chassis is as follows:

1. IF Chassis - Assembly and wiring complete, test is virtually completed.

2. LO Chassis - Except for the tripler (outside supplier), assembly is complete and wiring is now in progress.

3. Signal Chassis - Assembly and wiring complete, now being tested.

4. Filter Chassis - Chassis frame complete, now being machined and wired. Filters complete and ready for mounting on frame. Packaging of KCL components in component ovens complete, now being checked out.

The unit will be completed in the next report period and installed in the F-101 test aircraft. Wiring provisions and cockpit controls have been prepared to expedite the installation.

S-20,360

Copy 1 of 3

25X1 [redacted]

25X1

PROGRESS REPORT FOR THE MONTH OF MAY, 1962

Flights 11 and 12 were the only data producing flights in May, of which #11 was the best and amounted to four separate passes over Annapolis at 17,000 feet. The correlated data gives an easily recognized map of Annapolis and environs but is still far short of the ultimate resolution.

A meeting of all interested parties took place at Baltimore (21-22) May. The results and implications of which are far reaching. Westinghouse reviewed the S/N problem, and have shown that additional losses in the system and failure to meet some design specs have put us in trouble. When the parameters used in the analysis are adjusted for 17,000 ft. altitude, subsonic speeds, and reduced power output, the analysis and the data are in fair agreement. The conclusion, therefore, is that strong corrective measures should be taken in order to get the range performance we are asking. Such possible measures are: build a chirp transmitter; increase the length of the present ring; design a new transmitter; design a new R.F. amplifier with a lower noise figure; design a new correlator that can retrieve signals further down in the noise. In the meantime, power output has been increased from 2 to 8 watts

average and an improved recorder has been installed in the aircraft so that we anticipate considerable improvement in the next test flights. Proposals to design and build equipment that will more nearly realize final requirements and the detailed reasons therefore should be forthcoming in the near future.

In addition to the S/N problem, a report on the platform stability or antenna stabilization problem was also presented as an outgrowth of other work being done at Westinghouse. This report was somewhat inconclusive, the physical model and some of the basic assumptions on which the calculations were based have been questioned and the whole problem is being restudied. Nevertheless, it must be said that this problem is very much with us and the arguments go to how much stabilization is required and how degraded some uncompensated motion makes the final map.

The problem of low resolution continues to receive attention, the recorder has been greatly improved with the use of better CRT's, more effective shielding, and improved power supplies. The fibers continue to give trouble and the testing of the optical back-up recorder is slated for June. The Correlator will be waiting on new cylinder lenses until late June and not much can be done in that program, except train personnel, until they arrive.